DESIGN AND CONSTRUCTION OF A 500VA 50Hz SHELL TYPE STEP DOWN TRANSFORMER OF 230/110V

BY

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Dedication

To God almighty and to the Frank Okeke Family

Declaration

I, Okeke Chibundo Henry, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I hereby relinquish the copyright to the Federal University of Technology, Minna.

(Student)

(Project Supervisor)

Signature and Date

Signature and Date

External Examiner

Engr. A. G. Raji
(Head of Department)

Signature and Date

Signature and Date

Acknowledgement

Firstly I would like to appreciate God almighty the giver of life, without whom I won't be alive to write this project.

My appreciation also goes to all my family members for their financial and moral support and also for their prayers.

I would also like to appreciate my colleagues, all 500 level Electrical Engineering students, my close friends, Favour Nwabueze Anumobi Chidiebere, Ugochukwu Izuelumba, Uthman Abdullahi, Imoko David and Sunday Abel for their support.

I would also like to acknowledge my Supervisor, Prof Oria Usifo without whom this project work will not have been a success.

Abstract

The project is constructed to give an output power of 500Va and to generate an output voltage of 110V. The use of available materials for the transformer construction in order to reduce cost of production, and also the weight and size. To relate design analysis to construction model and to encourage local production of transformer. In the design of this transformer, various factors were considered; the frequency, power rating, core size, coil size, number of turns and other factors included in the design. This transformer can compare favorably with other transformers available in the market in terms of durability and cost effectiveness.

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CHAPTER ONE

Introduction

A transformer is a device that transfers electrical energy from one circuit to another by electromagnetic induction (transformer action) [3]. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction [4]. The electrical energy is always transferred without a change in frequency, but may involve changes in magnitudes of voltage and current. i.e. it can raise or lower the voltage in a circuit with a corresponding decrease in current. The physical basis of a transformer is mutual induction between two circuits linked by a common magnetic flux. [2]. Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of power grids [5]. All operate with the same basic principles, although the range of designs is wide. While new technologies have eliminated the need for transformers in some electronic circuits, transformers are still found in nearly all electronic devices designed for household ("mains") voltage.

Transformers are essential for high voltage power transmission, which makes long distance transmission economically practical. Transformers are one of the primary components for the transmission and distribution of electrical energy, because a transformer works on the principle of electromagnetic induction, it must be used with an input source voltage that varies in amplitude.

Most imported electrical items from America cannot be used directly in Nigeria because of their voltage rating (110) as compared to the voltage (230V) supplied by our power systems in Nigeria. This poses a big problem to people who purchase American produced electrical devices and intend to use them in Nigeria, United Kingdom, and other parts of the world that operate at 230V. This project is carried out to get a solution to the problem of using imported equipments in the electrical lab and other imported electronics which operate at 110V.

1.0 HISTORICAL BACKGROUND

The principle that allows us to make use of electromagnetism were only discovered in 1824, when Danish physicists Hans Oersted found out that a current flowing through a wire would deflect a compass needle. A few years later, it was fond that a moving magnetic field induces current into a wire. From this seemingly basic concept, the field of electromagnetism led to many discoveries:

Michael Faraday invented an induction ring on august 29, 1831. It was the first transformer, but Faraday used it only to demonstrate the principle of electromagnetic induction and did not foresee its practical uses. Michael Faraday carried out a series of experiments convincingly demonstrating the principle of electromagnetic induction. The first breakthrough in solving the problem of producing electricity from magnetism occurred on 29th August 1831 [6]. On that day, he took a soft iron ring 7/8 of an inch thick and 6 inches in external diameter. Around one half of the ring's circumference (which side he called A), he wound three coils of wire. Each coil had 24 feet of wire with the turns separated by wine and calico. On the other side (side B), but separated from side A by a distance, he wound 60 feet of wire in two separate coils in the same direction as the former coils. He connected the two coils on the side B in series and carried the connecting wire over a magnetic needle. He then connected one of the side A coils to a battery and closed the circuit on side A. The magnetic needle on side B immediately sensed it, oscillated and then returned to its original position. He observed a further disturbance of the needle only when he broke the battery connection on side A, but this was in the opposite direction. Faraday's report of this momentary disturbance of the magnetic needle was the first demonstration of what is known as electromagnetic induction today. Once he had got on the correct track, his experiments progressed very rapidly. This was the forerunner of the modern electrical transformer.

"Faraday's apparatus was designed to study whether a direct current (dc), and the magnetic field that was produced by a dc coil, induced voltage in another coil. It took several years of experimentation for Faraday to realize that constant dc does not have such effect, but the change, the increase or decrease of the current, in fact generates voltage in the other coil. Naturally, the apparatus was fed by a dc galvanic battery, since no other power source was available at the time. "Faraday found that a current of electricity flowing in a coil of wire wound around a piece of iron would convert the iron into a magnet and that, if this magnet were inserted into another coil of wire, a galvanometer connected to the terminals of the second coil would be deflected. " Faraday's invention contained all the basic elements of transformers - two independent coils and a closed iron core.

Nicolas Callan In 1836 understands the principle the more the turns a transformer has the larger the EMF it produces.

Russian engineer Pavel Yablockov in 1876 invented a lighting system based on a set of induction coil. The induction coil in this system operates as a transformer.

Lucien Gualand and Dixin Gibbs, they exhibited a device called a secondary generator in London 1881 and sold the idea to an American company, Westinghouse. They also exhibited the invention in Turin 1884, where it was used for an electric lighting system.

Hungarian engineers Zipernowsky, Blathy and Deri from the Ganz Company in Budapest created the efficient "ZBD" closed core model in 1885 based in the design of Gauland and Gibbs. They discovered that all former core (coreless or open core) devices were incapable regulating voltage and therefore impracticable. They also discovered the mathematical formular of transformer. Their patent application made the first use of the word "transformer" coined by Otto blathy

Willian Stanley an engineer for Westinghouse built the first practical transformer in 1885, after modifying the idea of Gauland and Gibbs. He built the core from interlocking E shape iron plates. The design was first used commercially on March 20, 1886.

Mikhail dolivo Bobrovoisky, Russian engineer developed the first three phase transformer in 18889.

Nikola tesla, invented the tesla coil in 1891, an air cored dual tuned resonant transformer for generating very high voltage at high frequency.

Van De Graff invented an insulated core transformer in 1891 which generates high voltage direct current using magnetic flux.

1.1 AIMS AND OBJECTIVES

Transformers have become an important component in electrical and electronics appliances, so the general objectives of this project is to construct a transformer that can step-down voltage to suit imported American electrical appliances or electronics. Other objectives includes

1. The project work enables or gives room to manufacturers to produce a more efficient unit.
2. The project work aim at designing and construction of transformer at a minimal cost using the best available materials.
3. To design and construct a transformer that copper losses, Eddy current losses and Hysteresis losses are reduced to the barest minimum.
4. To construct a transformer with high efficiency and performance, and also provide forehand knowledge to students interested in transformer studies.

1.2 METHODOLOGY

The construction of the transformer was based on the results obtained from the design experiment and calculations. A shell core is used as the core of the transformer. Two windings, primary and secondary were wrapped around the core. The core was laminated using the E and I type of lamination. Vanish was applied to the laminations to ensure proper insulation, the laminations were stacked properly and ensured they were tight. The primary winding carries a higher voltage and lesser current therefore a smaller diameter of wire is used for the winding (a higher standard wire guage). The secondary winding carries a lesser voltage and higher current therefore a bigger diameter of wire is used for the winding (a lesser standard wire guage).The lesser diameter wire was wound around the former, and was insulated from the bigger diameter wire which was wound around the former as the secondary winding. The windings were made very tight to reduce humming of the transformer. The power handling capability of the transformer is increased by cooling of the transformer with surrounding air. Copper or I^2R losses are prevented by proper standard wire guage in the primary and secondary winding. Proper lamination of the core reduces or eliminates Eddy current loss. Hysteresis losses are reduced by the use of proper core material. The best available, affordable materials were used for the construction.

CHAPTER TWO

Literature Review

2.0 THEORETICAL BACKGROUND

A transformer is a device that transfers electrical energy from one circuit to another by electromagnetic induction (transformer action) [3]. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core, and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. The electrical energy is always transferred without a change in frequency, but may involve changes in magnitudes of voltage and current. i.e. it can raise or lower the voltage in a circuit with a corresponding decrease in current. The physical basis of a transformer is mutual induction between two circuits linked by a common magnetic flux.

If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (V_S) is in proportion to the primary voltage (V_P), and is given by the ratio of the number of turns in the secondary (N_S) to the number of turns in the primary (N_P) as follows:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) voltage to be "stepped up" by making N_S greater than N_P, or "stepped down" by making N_S less than N_P.

2.1 THEORY OF AN IDEAL TRANSFORMER

An ideal transformer is one which has no losses i.e. its windings have no ohmic resistance, there is no magnetic leakage and hence has no copper and core losses. In other words, an ideal transformer consists of two purely inductive coils wound on a loss-free core. [2] Note: it is however impossible to realize such a transformer in practice.

In brief, a transformer is a device that

i. Transfers electric power from one circuit to another
ii. It does so without a change in frequency
iii. It accomplishes this by electromagnetic induction.

2.1.1 BASIC OPERATION OF A TRANSFORMER

In its most basic form a transformer consists of:

i. A primary coil or winding.
ii. A secondary coil or winding.
iii. A core that supports the coils or windings.

Referring to the transformer circuit in figure (1) below. The primary winding is connected to a 50 hertz ac voltage source. The magnetic field (flux) builds up (expands) and collapses (contracts) about the primary winding. The expanding and contracting magnetic field around the primary winding cuts the secondary winding and induces an alternating voltage into the winding. This voltage causes alternating current to flow through the load. The voltage may be stepped up or down depending on the design of the primary and secondary windings. [7]

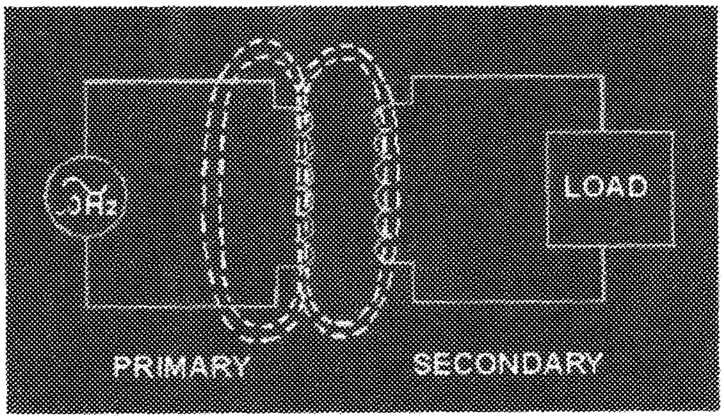


Figure 2.1. Transformer Action

2.1.2 BASIC COMPONENT OF A TRANSFORMER

i. THE CORE: this provides a path for the magnetic lines of flux.

ii. THE PRIMARY WINDING: this receives energy from the ac source.

iii. THE SECONDARY WINDING: this receives energy from the primary winding and delivers it to the load.

iv. THE ENCLOSURE: this protects the above components from dirt, moisture, and mechanical damage.

2.1.3 THE CORE

Transformers typically have cores made of high permeability silicon steel. The steel has a permeability many times that of free space. the core thus serves to greatly reduce the magnetizing current, and confine the flux to a path which closely couples the windings.

The composition of a transformer core depends on such factors as voltage, current, and frequency. Size limitations and construction costs are also factors to be considered. Commonly used core materials are air, soft iron, and steel. Each of these materials is suitable for particular applications and unsuitable for others. Generally, air-core transformers are used when the voltage source has a high frequency (above 20 kHz). Iron-core transformers are usually used when the source frequency is low (below 20 kHz). A soft-iron-core transformer is very useful where the transformer must be physically small, yet efficient. The iron-core transformer provides better power transfer than does the air-core transformer. A transformer whose core is constructed of laminated sheets of steel dissipates heat readily; thus it provides for the efficient transfer of power. The majority of transformers you will encounter contain laminated-steel cores. These steel laminations are insulated with a non conducting material, such as varnish, and then formed into a core. It takes about 50 such laminations to make a core an inch thick. One common design of laminated core is made from interleaved stacks of E-shaped steel sheets capped with I-shaped pieces, leading to its name of "E-I transformer" The purpose of the laminations is to reduce certain losses. Figure 2.1 shows a laminated core.

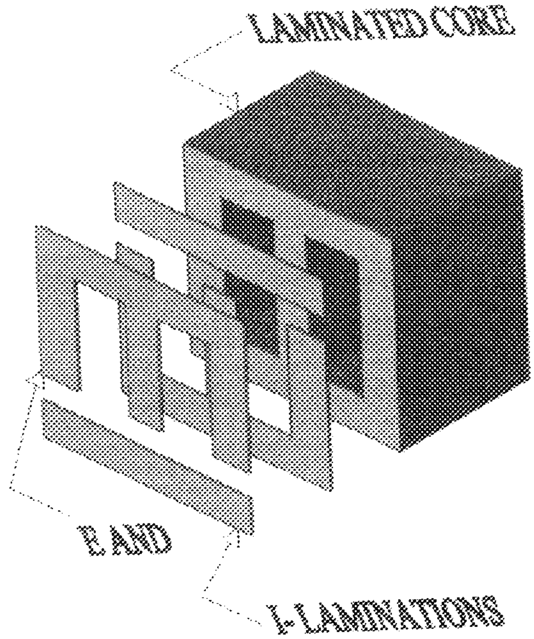


Figure 2.2 Laminated Core

2.1.4 TYPES OF TRANSFORMERS

i. Core type

ii. Shell type

2.1.4.1 CORE TYPE

It consists of two legged with the windings wrapped around the two limbs. It is easy to construct and maintain. It has large magnetic flux leakage. The core is shaped with a hollow square through the center. It is made up of many laminations of steel. Note: here the windings are wrapped around the lamination, the windings surrounds a considerable part of the core. Figure 2.3 illustrates this.

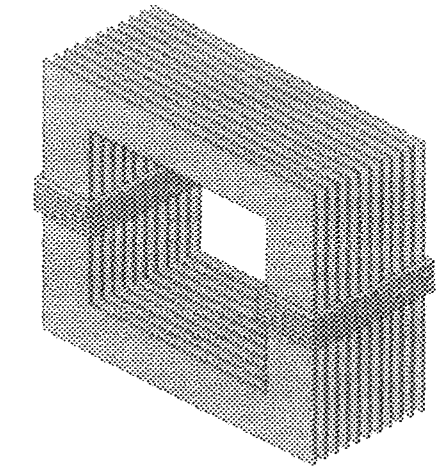


Figure 2.3 Core type

2.1.4.2 SHELL TYPE

It consists of three legged core with windings around the centre leg. It has high efficiency, because the magnetic flux is concentrated within the core. Each layer of the core consists of E- and I-shaped sections of metal. These sections are butted together to form the laminations. The laminations are insulated from each other and then pressed together to form the core. In shell type the laminations are fitted into the windings. The core surrounds a considerable portion of the windings. Figure 2.4 illustrates this.

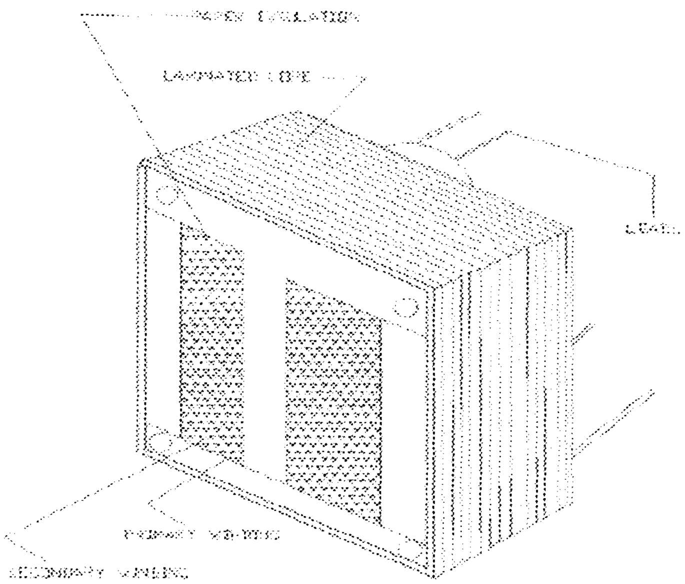


Figure 2.4 Shell type.

2.1.5 TRANSFORMER TURNS AND VOLTAGE RATIO

The total voltage induced into the secondary winding of a transformer is determined mainly by the ratio of the number of turns in the primary to the number of turns in the secondary, and by the amount of voltage applied to the primary [7]. This is expressed by the equation below.

$$\frac{E_s}{E_p} = \frac{N_s}{N_p} = K$$

Where:

N_p = Number of turns in the primary

E_p = Voltage applied to the primary

N_s = Number of turns in the secondary

E_s = Voltage applied to the secondary

K = Voltage transformation ratio.

If $N_s > N_p$ then transformer is a step-up transformer.

If $N_s < N_p$ then the transformer is a step-down transformer.

2.1.6 TRANSFORMER TURNS AND CURRENT RATIO

The ampere-turn is a measure of magneto motive force; it is defined as the magneto motive force developed by one ampere of current flowing in a coil of one turn. The flux which exists in the core of a transformer surrounds both the primary and secondary windings. Since the flux is the same for both windings, the ampere-turns in both the primary and secondary windings must be the same.

Therefore:

$I_pN_p = I_sN_s$

Where;

I_pN_p = Ampere - turns in the primary winding.

I_sN_s = Ampere - turns in the secondary winding.

2.1.7 POWER RELATIONSHIP BETWEEN PRIMARY AND SECONDARY

If voltage is doubled in the secondary, current is halved in the secondary. And also if voltage is halved in the secondary, current is doubled in the secondary. In this manner, all the power delivered to the primary by the source is also delivered to the load by the secondary (minus whatever power is consumed by the transformer in the form of losses).

If the turns ratio of the transformer is 1:2, the number of turns on the secondary is twice the number of turns on the primary. This means the opposition to current is doubled. Thus, voltage is doubled, but current is halved due to the increased opposition to current in the secondary. The important thing to remember is that with the exception of the power consumed within the transformer, all power delivered to the primary by the source will be delivered to the load. The form of the power may change, but the power in the secondary almost equals the power in the primary.

$P_s = P_p - P_l$

P_s = Power delivered to the load by the secondary.

P_p = Power delivered to the primary by the source.

P_l = Power loss in the transformer.

2.1.8 IDEAL POWER EQUATION

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power.

$P_{incoming} = I_P V_P = P_{outgoing} = I_S V_S$

giving the ideal transformer equation

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$$

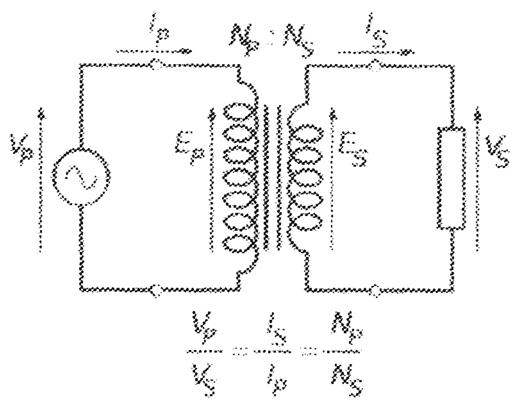


Figure 2.5 The ideal transformer as a circuit element

2.1.9 TRANSFORMER LOSSES

Practical power transformers, although highly efficient, are not perfect devices. Small power transformers used in electrical equipment have an 80 to 90 percent efficiency range, while large, commercial power line transformers may have efficiencies exceeding 98 percent.

The total power loss in a transformer is a combination of three types of losses. One loss is due to the dc resistance in the primary and secondary windings. This loss is called copper loss or I^2R loss. The other two losses are due to eddy currents and to hysteresis in the core of the transformer. Copper loss, eddy-current loss, and Hysteresis loss result in undesirable conversion of electrical energy into **heat energy.**

2.1.9.1 COPPER LOSS

This is the loss of energy in the form of heat dissipated by the resistance of the windings. Whenever current flows in a conductor; power is dissipated in the resistance of the conductor in the form of heat. The amount of power dissipated by the conductor is directly proportional to the resistance of the wire, and to the square of the current through it (I^2R). The greater the value of resistance or current, the greater is the power dissipated. The primary and secondary windings of a transformer are usually made of low-resistance copper wire. Copper loss can be minimized by using the proper diameter wire. Large diameter wire is required for high-current windings, whereas small diameter wire can be used for low-current windings.

2.1.9.2 EDDY-CURRENT LOSS

This is the heating of the core due to EMF being induced not only in the transformer winding but also in the core. Whenever the primary of an iron-core transformer is energized by an alternating-current source, a fluctuating magnetic field is produced. This magnetic field cuts the conducting core material and induces a voltage into it. The induced voltage causes random currents to flow through the core which dissipates power in the form of heat. These undesirable currents are called eddy current. To minimize the loss resulting from eddy currents, transformer cores are laminated. Since the thin, insulated laminations do not provide an easy path for current, eddy-current losses are greatly reduced.

2.1.9.3 HYSTERESIS LOSS

This is the heating of the core as a result of internal molecular structure reversal which occurs as the magnetic flux alternates. An amount of energy which is proportional to the area of the hysteresis is dissipated during each cycle. The loss is proportional to the area of the hysteresis loop.

2.1.10 TRANSFORMER EFFICIENCY

To compute the efficiency of a transformer, the input power and the output power of the transformer must be known. The input power is equal to the product of the voltage applied to the primary and the current in the primary. The output power is equal to the product of the voltage across the secondary and the current in the secondary. The difference between the input power and the output power represents a power loss. You can calculate the percentage of efficiency of a transformer by using the standard efficiency formula shown below:

$$\text{Efficiency (in \%)} = \frac{P_{out}}{P_{in}} \times 100$$

Where:

P_{out} = total output power delivered to the load

P_{in} = total input power

CHAPTER THREE

3.0 DESIGN ANALYSIS AND DATA CALCULATIONS

3.1 BLOCK DIAGRAM

In order to meet the objective of the project, the operation of the entire system is divided into five basic units. They are the input power supply unit, input indicator unit, the main circuit, output unit, output indicator unit.

The block diagram is shown below

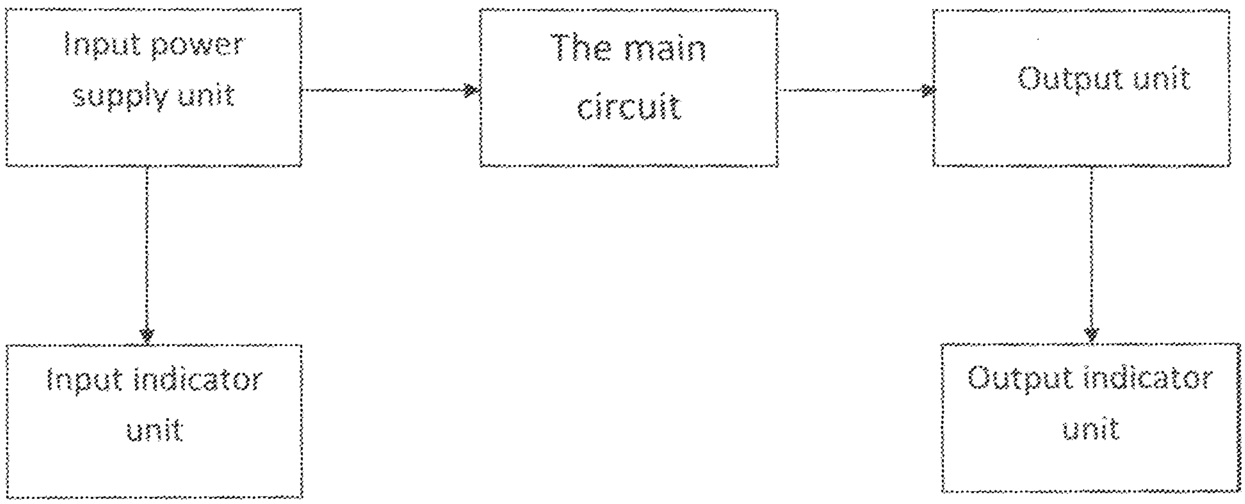


fig 3.1 block diagram of 500VA transformer of 230/110V

3.1.1 THE INPUT SUPPLY UNIT

A supply voltage of 230 volts is expected from PHCN. This is fed to the system, for the required operation of the system.

3.1.2 THE INPUT INDICATOR UNIT

This is used to measure input supply from the mains. It is a digital multi meter

3.1.3 THE MAIN CIRCUIT

The main circuit consists of the laminated steel core. It is of high silicon content, having high permeability and low hysteresis losses. The windings were wound round the former and properly insulated; the output was tapped from the secondary side of the windings after specific number of windings.

3.1.4 THE OUTPUT UNIT

The output voltage was gotten from the secondary windings and fed into the output sockets. The voltage is as a result of the number of turns in the secondary.

3.1.5 THE OUTPUT INDICATING UNIT

This is used to measure the various output voltages from the outlet. It is also a digital multimeter.

3.2 DESIGN ANALYSIS

The design analysis involve a 500VA with 230V as input voltage stepping it down to 110V.

3.2.1 Given parameters:

3.2.1.1 Description: Single phase transformer

Rated power: P = 500VA

Primary voltage: V_{in} = 230V

Secondary voltage: V_{out} = 110V

Frequency: f = 50Hz

Factor K for single phase shell transformer = 1.1

Maximum flux density in the core, B_m = 1.6 tesla

Window space = 0.3

Average current density = $2.5 \times 10^{6} A / m^{2}$

Thickness of core sheet = $0.03mm$

Density of steel = $7.55 \times 10^{3} kg / m^{3}$

3.2.2 Designing of the core

$$E_t = \frac{V}{N} = K\sqrt{Q}$$

E_t = voltage per turn

Q = rated KVA

K = 1.0 (for single phase shell transformer)

$$E_t = \frac{V}{N} = 1.0\sqrt{0.5}$$

$= 0.7071$

Cross sectional area of the core (Ai)

$E_t = 4.44fBmAi$

$Ai = \frac{E_t}{4.44fBm}$

$= \frac{0.7071}{444 \times 50 \times 1.6}$

$= 1.990709 \times 10^{-5}\,m^2$

$= 19.91\ cm^2$

Gross area of the core A_g

$A_g = \frac{A_i}{S_f}$

S_f = stacking factor

$A_g = \frac{19.91}{0.9}$

$= 22.12\ cm^2$

3.2.3 Selection of number of windings

Number of primary turns $= \frac{primary\ voltage}{E_t}$

$= \frac{230}{0.7071}$

= 325 turns

Number of secondary turns = $\frac{secondary\ voltage}{Et}$

$= \frac{110}{0.7071}$

= 156 turns

3.2.4 Calculation for winding gauges

3.2.4.1 Calculation for the primary winding:

Power = voltage × current

$P = V \times I$

$I = \frac{P}{V}$

$= \frac{500}{230}$

= 2.174A

Current density = $\frac{current}{area}$

Area = $\frac{current}{current\ density}$

Area = $\frac{\pi d^2}{4}$

$\frac{\pi d^2}{4} = \frac{2.174}{2.5}$

$$\frac{\pi d^2}{4} = 0.945$$

d = 1.052mm

From the SWG table gauge 19 was chosen for the primary winding.

3.2.4.2 Calculation for the secondary winding:

P = VI

$$I = \frac{P}{V}$$

$$= \frac{500}{110}$$

= 4.545A

$$\frac{\pi d^2}{4} = \frac{current}{current\ density}$$

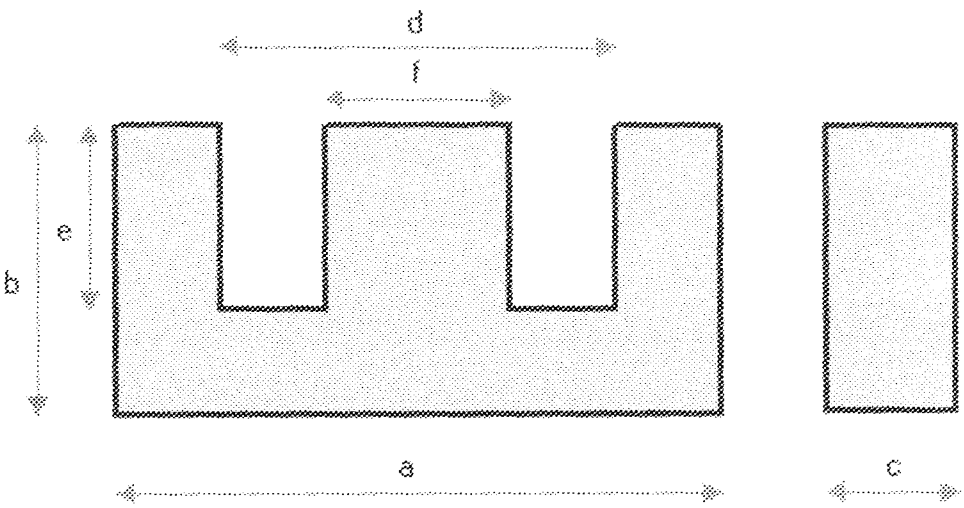
$$\frac{\pi d^2}{4} = \frac{4.545}{2.5}$$

d = 1.521mm

From the SWG table gauge 17 was chosen for the secondary winding

3.2.5 Choice of the trade type lamination for this construction

Based on calculated value we have to choose the type of lamination that is available on the market.



- Total width = a = 95mm
- Column width = f = 32mm
- Width d = 65mm
- Column height = e = 48mm
- Side height = b = 64mm
- Lamination thickness = 0.5mm

3.2.6 Calculation of the total number of lamination of the transformer:

c = thickness of the laminated core

s = thickness of one of the laminations

$$n = \frac{c}{s} = \frac{35}{0.5} = 70$$

STANDAR WIRE GUAGE

SWG	Dia(mm)	SWG	Dia(mm)	SWG	Dia(mm)	SWG	Dia(mm)
1	7.6200	14	2.0320	27	0.4166	40	0.1219
2	7.0104	15	1.8288	28	0.3759	41	0.1118
3	6.4008	16	1.6256	29	0.3454	42	0.1016
4	5.8928	17	1.4224	30	0.3150	43	0.0914
5	5.3848	18	1.2192	31	0.2946	44	0.0813
6	4.8768	19	1.0160	32	0.2743	45	0.0711
7	4.4704	20	0.9144	33	0.2540	46	0.0610
8	4.0640	21	0.8128	34	0.2337	47	0.0580
9	3.6576	22	0.7112	35	0.2134	48	0.0406
10	3.2512	23	0.6096	36	0.1930	49	0.0305
11	2.9464	24	0.5588	37	0.1727	50	0.0254
12	2.6416	25	0.5080	38	0.1524		
13	2.2368	26	0.4572	39	0.1321		

Table 3.1 SWG (standard wire gauge) to mm conversion

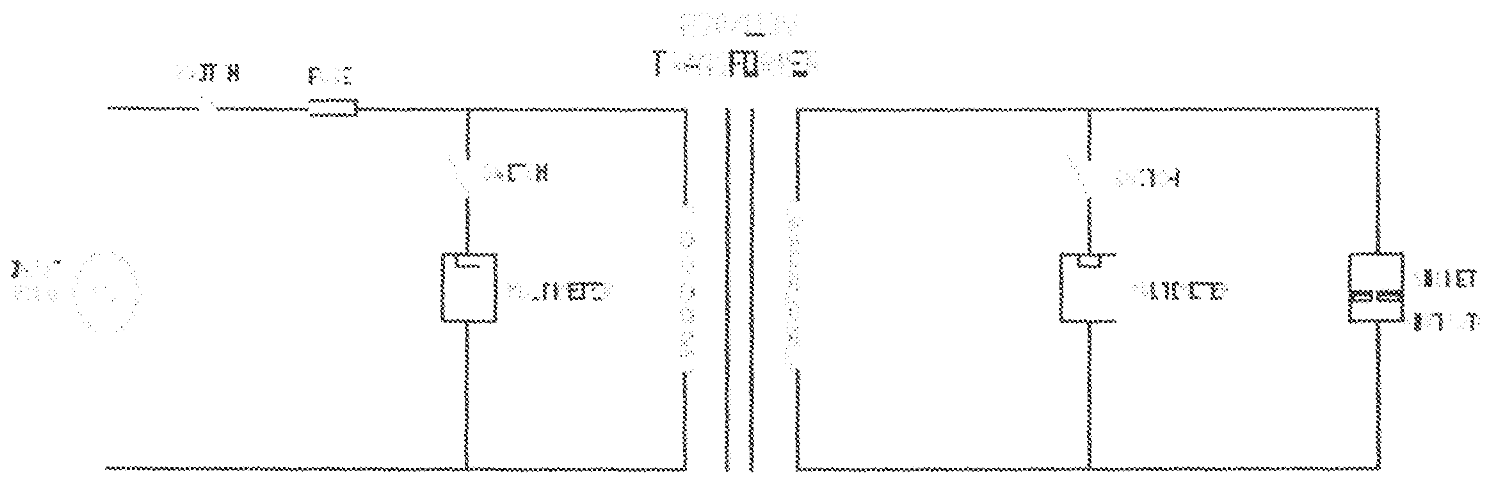


FIG. 3.4 CIRCUIT DIAGRAM OF 300VA TRANSFORMER OF 230V/110V

CHAPTER FOUR

PERFORMANCE TESTS, RESULTS AND DISCUSSION

4.1 BILL OF QUANTITY AND COST ESTIMATE

A bill of quantity was carried out to ascertain the actual cost of materials in the construction of this transformer, and this will also ascertain the net price of the transformer.

S/NO	DESCRIPTION OF ITEM	QUANTITY	UNIT/RATE (Naira)	TOTAL AMOUNT(Naira)
1	Plastic former	1	50	50
2	Laminations	70	5	350
3	Primary Winding wires	3(lines)	100	300
4	Secondary winding wires	3(lines)	100	300
5	Vanish		50	50
6	Digital multimeter	2	500	1000
7	Casing	1	1200	1200
8	Total cost			3250

4.2 PERFORMANCE TEST

The test carried out on a transformer helps to ascertain its performance and efficiency when operated properly. The following tests were carried to determine the constant of the equivalent circuit of a transformer which is then used to calculate its performance;

i. Short circuit tests

ii. Continuity tests

iii. Loading tests

4.2.1 SHORT CIRCUIT TEST

The short circuit test of a transformer provides the copper losses of the transformer windings when it supports the rated load. Voltage, current, and the input real power measurements enable us to compute equivalent resistance and reactance of windings referred to the primary side when the secondary side of the transformer is short circuited.

In this test one side of the winding is short circuited across its terminal and a reduced voltage i.e low voltage is applied to the other terminal. The reduced voltage has a specific value of rated current to flow in the short circuited terminal. The choice of the terminal to be short-circuited is usually determined by the measuring equipment available for the test.

4.2.2 CONTINIUITY TEST

This test is carried to ensure that no open circuit in the windings during and after construction. This is very important not only during the constructional stage, but also after the construction. This test was carried out by making use of multi-meter to confirm that there is no short circuit along the part of the winding.

4.2.3 LOADING TEST

This test shows the characteristics behavior of the power equipment to load variation. When the secondary output is loaded, a drop in voltage is observed due to the internal resistance and leakage reactance of the winding at any load condition, the net flux passing through the core is approximately the same at the no load.

4.2 RESULTS OBTAINED

These are the results from the tests carried on the transformer.

Table 4.2 Short Circuit Test

Input voltage(v)	Wattage (watts)	Current(A)
5	3	0.55
10	8	0.73
15	15	0.95

Table 4.3 No Load Test / Open Circuit Test

Primary voltage(v)	Secondary voltage(v)	Wattage(W)	Current(A)
180	86	4	0.04

4.3 EFFICIENCY

In measuring the transformer efficiency, the losses are to be determined. Hence, the efficiency can be calculated from the relation:

$$\text{Efficiency} = \frac{output\ power}{input\ power}$$

$$= \frac{output\ power}{input\ power + losses}$$

$$\text{Efficiency} = \frac{output\ power\ (VA)}{input\ power\ (VA)}$$

In power transformer operation at a constant voltage and current, the iron losses are assumed to be constant over the working current range. It can also be instantaneous

Copper losses = iron losses

4.4 DISCUSSION OF RESULT

From the performance test carried out on the transformer, it can be observed that it has low losses when the desired input of 220-230v is applied from the input it gives an output of about 105-110v and an appreciable efficiency. However, its performance shows a high level of efficiency at load point, and mode of operation is simple.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In the design and construction of the 500Va 230v/110v transformer, some given specification had to be met; power rating output voltages, reliability and the strength of the transformer. There were variations in the desired output voltages due to drop in the resistance which amount to losses and volt per turn approximation and lack of required size of core.

Improved efficiency can be achieved when the stacking is more firm and there are no leakages.

5.2 PROBLEM ENCOUTERED

For most specific work there are problems attached to it due to the techniques involved in the construction, packaging and testing of the work. Most of the problems encountered were in the areas of non availability of enough text on the project topic, equipment to test the work and lots more.

5.3 RECOMMENDATION

I would recommend that the stacking of the lamination be done by machine and also the windings, for reliability of the transformer. A digital display can be added in the more improved work to add aesthetics to the work. A computer aided design and good computer graphics be employed in the area of design to have improved performance and also to reduce stress.

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